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Interactive comment on "Projected pH reductions by 2100 might put deep North Atlantic biodiversity at risk" *by* M. Gehlen et al.

Anonymous Referee #1

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Review of Ghelen et al.

This manuscript uses a suite of climate models to predict future changes in pH in deep waters of the North Atlantic. These are then superimposed on the distribution of seamounts and canyons to predict biodiversity threats in 2100. Approximately 17% of the seafloor below 500 m is predicted to experience pH declines of 0.2 pH units. The tremendous stability of conditions in deep water and historical changes recorded in the geologic record, suggest this amount of pH decline is potentially dangerous to deep-ocean biodiversity.

The modeling component of this paper seems sound, although this is not my area of expertise. Work by others including some of the co-authors have predicted seafloor changes in temperature, pH, POC flux and oxygen (Bopp et al. 2013, and pointed out

impacts on deep biodiversity (Mora et al. 2013). This paper might want to devote more space to acknowledging and reviewing that earlier work. Has a similar approach been taken with warming or oxygen?

Please consider the following issues and suggestions:

Please provide the justification for selection of a 500 m upper limit of analysis. This is not an upper limit for deep-water corals or sponges is it? It seems that a significant component of deep biodiversity may fall between 200-500 m.

Do the effects of a 0.2 or 0.3 pH unit decline depend on the baseline or starting point? What are the absolute pH values at 500, 1000, 2000 m in the deep Atlantic Ocean? Is anything known about natural pH variability in the deep Atlantic and how this changes with water depth, latitude or region?

There is limited discussion of the mechanisms by which pH might affect biodiversity. Is it through effects on calcification? Acid-base regulation? Energetics (which are discussed somewhat)? If corals are of major concern, please discuss what a 0.2 or 0.3 pH decline corresponds to with regard to aragonite saturation state. It would be appropriate to also calculate and map changes in Omega (aragonite) and determine what fraction of the seamounts or canyons will be exposed to specific omega decline levels. It may be that we have more knowledge of saturation state requirements than pH tolerances.

Several assumptions seem to be made: One is that there is no adaptation potential. . .. Over the next 85 years – is this what the authors believe? Do they expect any synergistic interaction with declining oxygen?

Additional points and considerations that could enhance this work.

a) Are there actual biodiversity data to show that seamount and canyon biodiversity is higher than other settings (continental slope, mid-ocean ridges, vents, basins, fjords, carbonate mounds, or other features). For what groups? b) What fraction of the deep-

ocean corals occur on canyons and seamounts as opposed to other features (slopes, mounds, mid ocean ridges etc.)? Would the major messages change if these other settings were considered? c) The beginning of the paper could do more to justify why the focus is on biodiversity and not, for example on fisheries? Habitat support or other ecosystem services? Is biodiversity being used as a proxy for something else? d) What is the support for extracting thresholds from the paleoceanographic literature? The time scales seem wrong for comparison with current change. Why wouldn't a 0.1 pH decline over 100 years be more significant than a 0.2 pH decline over thousands or tens of thousands of years?

Summary: This paper addresses issues relevant to Biogeosciences, and presents original data, although the general concept of predicting change and superimposing this on bathymetry is not entirely novel. The writing is generally clear and the authors provide a strong case to substantiate their interpretations. The methods are valid but the assumption that a 0.2 unit decline in pH will alter deep-sea biodiversity remains to be tested broadly.

Technical Corrections: Pg 8609 line 9 the deep benthic environment; also. . .You don't actually report real consequences. Pg 8610 line 4 – Mora et al. 2013 should be cited as considering consequences of OA in deep water. Pg 8610 line 7 deep sea is only hyphenated when used as a double adjective.ysis. Pg 8610 line 9 I question whether mineral extraction is dominant in the deep-sea – it has not really happened yet. Pg 8610 line 18. Need a citation after. . . taxa. Pg 8618 line 18 please define what depths are mean by 'deep water' Pg 8619 line 16 please define what is meant by 'climate change' – is this warming? Pg 8620 line 26. Other good citations include Buhl-Mortensen et al. 2010 (Marine Ecology) and other papers by that author. Pg 8621 line 10. So given the threat to deep protected areas – what do the authors recommend be done? Set aside larger protected areas? Avoid climate change-impacted areas?

Fig. 4 Can you comment on the biology in the regions shown in orange with greatest pH change?

Interactive comment on Biogeosciences Discuss., 11, 8607, 2014.